NAVAL POSTGRADUATE SCHOOL
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THESIS

CONSIDERATIONS FOR THE DESIGN AND IMPLEMENTATION
OF A
MANAGEMENT SUPPORT SYSTEM
FOR THE
ELECTRONIC WARFARE SYSTEM SUPPORT LABORATORY

by

Harry G. Banks III

June 1985

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Considerations For The Design and Implementation of a
Management Support System For The
Electronic Warfare System Support Laboratory

by

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ABSTRACT

This thesis presents a review of current literature on management support system development, some current management philosophy, and an organizational analysis of the Electronic Warfare System Support Laboratory located at the Pacific Missile Test Center Pt. Mugu, CA. Using the knowledge gained on management system development and the organizational analysis, appropriate objectives and requirements for a management system were developed for the laboratory.

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I. INTRODUCTION

A. BACKGROUND

With technological advances a vast amount of information is available and it is becoming increasingly difficult to utilize this information properly. Minzberg states that a manager is "...the focal point in the general flow of information and in the handling of general disturbances." [Ref. 1: p. 4] Naisbitt [Ref. 2: pp. 1-33] lists the transition of the American society from an industrial society to an information society as one of ten "megatrends" currently taking place. Certainly, a key factor in determining a managers success is going to be his ability to properly utilize all the information made available to him.

A Management Support System (MSS) will help a manager manage information. As task manager of the Electronic Warfare System Support Laboratory (EWSSL) the author wants to be sure he is using the most up to date methods to manage the laboratory.

This thesis develops the requirements for a MSS for the EWSSL. The EWSSL is located at the Pacific Missile Test Center (PMTC), Pt Mugu, California. The EWSSL generates test configurations, realistic battle situation scenarios, and data acquisition and processing capabilities to test Electronic Warfare (EW) systems and suites in a real-time dynamic environment. Navy, Air Force, and Army developers of EW systems utilize the EWSSL. In the past 15 years the size of the EWSSL has greatly increased. Personnel has changed from two electronic engineers and one electronic technician providing technical support and a branch head providing part time managerial support in 1969 to a crew of

15 electronic engineers, three electronic technicians, a program analyst, and a full time branch head. Simulation equipment has changed from one target tracking radar simulator to four target tracking radar simulators and four software support stations. The annual budget has gone from 100 thousand dollars to three million dollars.

B. NEED AND OBJECTIVE

1. Need

Managing the EWSSL has become increasingly complex. Assembling the information required for program planning, both to the Naval Air System Command (NAVAIR) sponsors and PMTC chain of command, occupies a great deal of time. Not having the proper information readily available has caused delays in response resulting in missed funding. Long range planning for the EWSSI requires a thorough understanding of the Navy's EW development program as well as defense industry trends. Information sources and interfaces are not formally defined and change continually.

2. Objectives

The objectives of this thesis are:
1. to identify the criteria and considerations appropriate for a MSS to be utilized in the EWSSL.
2. to provide a brief summary of management theory evolution and effective management practises as they influence information systems.
3. to identify some current organizational assessment techniques.
4. to examine the existing EWSSL environment and identify roles, responsibilities, organizational relationships, and information flow and controls.

5. to stipulate the information and control requirements for an EWSSL MSS.

6. to recommend a development plan for the EWSSL MSS.

C. METHODOLOGY

1. Review of Current Literature

An extensive research of existing literature was conducted to gain an understanding of MSS development. Other topics investigated included organizational analysis, strategic planning, and management in bureaucracies. This was accomplished by reviewing current books, periodicals, and reports. Useful documents are listed in the bibliography.

2. Personnel Contacted

Information for this thesis has been gathered largely through personal contact with people working with the EWSSL. This includes personnel employed in the EWSSL, EWSSL sponsors, and users of the laboratory.

3. Analysis

The EWSSL was analyzed using the Network organizational model detailed in Chapter III. Requirements were determined using decision analysis. Input and output volumes were determined from discussions with EWSSL personnel.

D. THESIS ORGANIZATION

The knowledge gained from the literature search has determined the thesis organization. The thesis is organized much like an MSS is developed.

Chapter II is a tutorial on current approaches to MSS development. The chapter shows how a complete MSS can be developed and then discusses the components of the MSS that this thesis deals with. The chapter focuses on general criteria of an MSS describing the criteria so that the reasoning behind current MSS development can be understood.

Chapter III presents some ideas to consider when developing an MSS. First a brief history of management theory evolution is given. Next, some ways to analyze an organization are described and finally some current ideas on management philosophy are discussed.

Chapter IV describes the existing EWSSL. The EWSSL is described using the Network model detailed in Chapter III.

Chapter V uses the information obtained in Chapter IV to develop the requirements for a MSS for the EWSSL. The MSS is subdivided into related functions and the required inputs, outputs, and processes are identified.

Finally, Chapter VI provides a brief summary of the thesis and presents the recommendations and conclusions of the author.

II. MSS DESIGN CRITERIA AND CONSIDERATIONS

A. SYSTEM ANALYSIS

To implement an idea it is best to have a well thought out plan. Current thinking favors the systems approach. The word system has many definitions. One definition of system found in Webster's dictionary that is appropriate is "A complex unit formed of many often diverse parts subject to a common plan or serving a common purpose." The systems approach solves a problem by dividing the task into clearly defined, manageable steps. The basis of the systems approach is the scientific method [Ref. 3: p. 101] that is used in studying the physical sciences. The steps in the scientific method are:

1. observing
2. formulating a hypothesis
3. predicting what will happen
4. testing the hypothesis

Table I lists the steps of the systems approach and some questions that must be asked before continuing to the next step [Ref. 3: p. 102]. Table II applies the systems approach to strategic planning [Ref. 4: pp. 110-117]. Table III applies the systems approach specifically to the development of an MSS and lists some tasks that must be performed during each step. This approach was developed by Rigo [Ref. 5]. Although the information presented in the three tables are quite similar each provides a slightly different viewpoint that should be appreciated.

TABLE I

The Systems Approach – Steps and Decisions

STEPS	DECISIONS

1. Define the problem

Where is the problem?
What is causing the problem?
Is this the true cause?

2. Gather the data describing the problem

Does new data need to be gathered,
or does data already exist?
Who will gather the data?
How will the data be gathered?

3. Identify alternate solutions

How many alternatives should be identified?
Are there other alternatives?
Are these alternatives feasible?

4. Evaluate the alternatives

Which criteria should be used?
How does each alternative measure up
to each criteria?
Do all the criteria have equal weight?

5. Select the best alternative

Do I have enough information to make
a decision?
Which alternative measures up best to
the criteria selected?
Was the selection process fair?

6. Implement the solution

When should the solution be implemented?
How should solution be implemented?
Who should implement the solution?

7. Evaluate solution

Who should evaluate solution?
How well is solution meeting objectives?

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TABLE II

Steps In Strategy Development

1. Goal Formulation

2. Current Objectives and Strategy

3. Environmental Analysis

4. Resource Analysis:
   Organizational Strengths and Weaknesses

5. Strategic Opportunities and Threats

6. Determine Change Required in Current Strategy

7. Strategic Decision Making:
   Develop, Evaluate, Select Alternatives

8. Implement Strategy

9. Measurement of Progress

TABLE III
Management Support System Development

PHASE	TASK
Initiation	Define the Problem
	Define the Objectives
	Statement of Anticipated Benefits
Survey	Analysis of Current Situation
Requirements	Define User Requirements
	Identification of Alternatives
	Gross Design -inputs, outputs, processing
Preliminary Design	Selection of Gross Design Alternatives
	Preparation of Functional Specifications
	Cost/Benefit Analysis
Detail Design	Preparation of System and Programming Specifications
	Training Plan and Documentation Begun
Development	Programs Written Hardware Procured
Implementation	System Tested
	Interfaces Tested
	Operational Acceptance
Evaluation	Cost and Performance Evaluated
	Modifications as Required

B. MSS DESIGN CRITERIA

In the development of an MSS there are certain criteria one is trying to satisfy. Sprague [Ref. 6: pp. 94-96] discusses a general set of criteria.

1. An MSS should support users at all levels.
2. An MSS should support different types of decisions.
3. An MSS should support all phases of the decision making process.
4. An MSS should support different decision making processes.
5. An MSS should be easy to use.

By describing these criteria we can better understand what must be included in an MSS.

1. User Levels

In _Planning and Control Systems: A Framework For Analysis_ Robert Anthony developed a classification scheme that divided managerial functions or processes into three levels. He believed that the differences between these categories were so significant that control systems designed for each process would have substantially different characteristics.

Anthony's first category is called "strategic planning". Strategic planning is defined as " the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to obtain these objectives, and on the policies that are to govern the acquisition, use and the disposition of these resources." [Ref. 7: p. 16] Anthony made several points with respect to strategic planning. first, strategic planning focuses on the choice of objectives for an organization and on the means required to achieve these objectives. Because of this, problems in this area tend to involve long range

planning and require predicting the future of both the organization and its environment. Secondly, the strategic planning process usually involves a small group of high level people in the organization and is nonrepetitive and often very creative and insiteful. The types of decisions made have many variables and are usually unstructured. The results of these decisions are policies and procedures which have to be analyzed over time and even then are extremely difficult to evaluate.

The second category defined by Anthony is management control. This process is defined as " ...the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organizations objectives." [Ref. 7: p. 17] There are three aspects of this function. This process involves managers who must accomplish their tasks through interaction with a large number of people. These tasks are defined from the objectives and policies that have been determined in the strategic planning process. The criteria for evaluating the actions taken are effectiveness and efficiency.

Anthony's third category is operational control which is defined as " the process of assuming that specific tasks are carried out effectively and efficiently." [Ref. 7: p. 18] The difference between management control and operational control is that management control is focused on planning and execution in general whereas operational control is focused on specific tasks.

2. Types of Decisions

Simon in The New Science Of Management Decision has defined decision types as either "programmed" or "unprogrammed". Programmed decisions are defined as those decisions which are repetitive and routine and a definite procedure has been established for solving them each and

every time they occur. Nonprogrammed decisions are those
for which there is no firm decision making process.
Nonprogrammed decisions are not repetitive. These types of
decisions occur because of time constraints, lack of knowl-
edge, a large search area, or nonquantifiable data.
Nonprogrammed decisions require individual action using
intelligent, adaptive problem solving techniques.

People at all levels of management are required to
solve both types of decisions.

Another classification scheme of decision types is
Thompson's, as interpreted by Hackathorn and Keen [Ref. 8].
They classify decisions as either independent, sequential
interdependent, or pooled interdependent. Independent deci-
sions are where a decision maker has full responsibility and
authority to make a complete implementable decision.
Sequential interdependent decisions occur when a decision
maker makes part of a decision which is then passed on to
someone else. Pooled interdependent decisions are where the
decision results from negotiations and interaction among
several decision makers. The decision makers involved
process different knowledge that must be combined to make
the decision.

3. Phases of the Decision Making Process

Simon [Ref. 9] determined that there are several
stages to the decision making process. He has divided the
decision making process into three phases: intelligence,
design, and choice. The intelligence phase is where the
environment is searched for problem areas that may require
decisions. Raw data are obtained, processed, and examined
for information that may identify problems. The design
phase is where possible courses of action are invented,
developed and analyzed. This involves understanding the

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problem, generating solutions, and testing the solutions for feasibility. The choice phase is where a particular alternative developed in the design phase is selected and implemented. Table IV shows some common activities of each phase [Ref. 6: p. 105].

TABLE IV
Phases of the Decision Making Process

INTELLIGENCE

Gather Data
Identify Objectives
Diagnose Problem
Validate Data
Structure Problem

DESIGN

Gather Data
Manipulate Data
Quantify Objectives
Generate Alternatives
Assign Risks to Alternatives

CHOICE

Generate Statistics on Alternatives
Simulate Results of Alternatives
Explain Alternatives
Choose Alternative
Explain Choice

4. Different Decision Making Processes

Every manager has a unique decision making style which may involve different kinds of decision making processes [Ref. 3: pp. 120-123]. There are three dimensions to an individuals decision making style. These dimensions are their problem sensing, information gathering, and information using styles.

There are three categories of problem sensing styles. these categories are problem avoider, problem solver, and the problem seeker. A problem avoider takes a positive attitude and assumes that everything is fine. The possibility of problems is blocked out by ignoring information or avoiding thorough planning. A problem solver does not look for problems but does not ignore them either. If a problem arises it is solved. A problem seeker actively searches for problems to solve by thoroughly analyzing all available information and strong planning.

The way people organize the various sources of information that are received daily can be divided into two information gathering styles. These styles are the perceptive style and the receptive style. An individual who utilizes the perceptive style adheres to management by exception and filters out everything not meeting certain criteria. In the receptive style the individual wants to analyze all available information and then determine its meaning.

There are two information using styles, systematic and intuitive. A systematic approach is where attention is focused on a prescribed method for problem solving such as the systems approach. The intuitive individual does not adhere to a single approach but instead uses any process that seems to fit the situation.

A MSS must be developed with a thorough under-
standing of the decision making styles of the individuals
who will be utilizing the system.

5. Ease of Use and Modification

An MSS must be easy to use otherwise a manager will
find other means to get his job done. Easy to use means
different things to different people.   As discussed earlier
people have different ways of solving problems.   They also
have different interpretations as to what easy to use
implies.

Some thoughts on what features an MSS might employ
to be considered easy to use are provided by Sprague
[Ref. 6: pp. 101-107].

To be easy to use an MSS should have representa-
tions,   operations, memory aids, and control mechanisms.
Representations consist of flowcharts, diagrams, or print-
outs in the same style as was done by hand before the MSS
was available. The representations should be familiar to the
user and support his or her method of conceptualization.
The MSS should provide operations which support all three
phases of the decision making process and if possible inte-
grate them.   Memory aids should be in the form of long term
aids such as databases and short term aids such as scratch
pads. There should also be control mechanisms to help learn
the new skills employed by the MSS.

C. ANALYSIS AND REQUIREMENTS

The next step in the development of an MSS is an anal-
ysis of the current situation.   From this analysis require-
ments can be determined that will provide the criteria for
design.

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Analysis consists of a thorough description of the current situation and determining the information needs of the organization. The analysis must define the organizations roles and interrelations with other organizations. A common analysis approach is to develop a model of the organization and perform the analysis using the model.

To determine specific information needs detailed questions must be asked of the individuals in the organization. The following questions should be answered by people who will be utilizing the MSS.

1. What information do you get?
2. How often do you require this information?
3. Is this information received on time?
4. What information would you like?
5. What type of studies do you request?
6. What decisions do you make?
7. How often do you make these decisions?
8. Are these decisions always made on time?
9. What topics must you be familiar with?
10. What magazines or trade journals do you require?
11. What three improvements would you make to the current information system?

D. MSS DESIGN CONSIDERATIONS

1. Functional MSS

As was seen earlier management levels can be broken down into three categories: strategic planning, management control, and operational control. It would seem that it would be logical to develop MSSs this way also. However this is not the case. What is generally done is that a functional MSS is developed. The most common functions are marketing, manufacturing, and financial. The functional MSS can be structured to summarize and condense the information to that required for each of the three managerial levels.

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2. Iterative Development

It is not always possible to know all that you need to include in an MSS. Also, when you begin to use the MSS it may become obvious that changes are required. For these reasons it is sometimes wise to develop the MSS in an iterative process [Ref. 6: pp. 139-141]. Start with a well understood portion of the overall organization and implement it. Then let the system grow in small steps that best fit the people and the functions required. This iterative or incremental approach has several advantages. First, it is possible to improve the quality of information before design decisions are required. It is possible to implement only the portion of the MSS that is well understood and wait until information becomes available or knowledge increases because of experience to continue. Trial balloons can be experimented with and a systematic approach can be utilized. Second, it stimulates flexibility, creativity and opportunism. Development effort can change to focus on the most critical problem at hand. Sequencing and lead time problems can be worked on as required. Third, it is possible to overcome political and emotional barriers to change. A successful small portion of the MSS will build political support to continue the overall development. Incrementalism provides time to overcome opposition to change. Fourth, incrementalism allows time to create personnel and organizational commitment to the MSS.

III. SOME MANAGEMENT TOOLS

This chapter will discuss the evolution of management theory, some current theories, and methods of analyzing organizations.

A. MANAGEMENT THEORY HISTORY

In order to develop an effective MSS managers must be able to relate to the MSS personally. Managers will look for different capabilities in an MSS based on their management theory background. One needs to know the theories they might believe in to get clues as to what their approach to problem solving is.

A theory is a set of ideas that is useful in describing some phenomenon. Simply stated it is what ever you carry around in your head to help you understand life. A theory is usually evaluated by its usefulness. For a theory to be good it must have the following capabilities:

1. Accurately reflect reality
2. Cover abroad range of situations
3. Be consistent
4. Be open to improvement and change

Peoples experiences generate their most meaningful theories. A lot of management theory is generated by the social, political, and technical development of society at the time. The theory must be consistent and compatible with what is happening in society. It is therefore possible to extrapolate from society where organizations are going. The following is a brief summary of organizational theory development.

1. 1900 Scientific Management

Prior to the 1900,s physical coercion was the main tool of maintaining order in an organization. Extended kinships and the military were other existing organizations. The industrial revolution of the mid 1800,s changed the environment. There was a great deal of enthusiasm and optimism with science during this time period.

Frederich Taylor is known as the father of scientific management. He is affectionately known as "Fast Freddie" because he used time and motion studies of American steel workers to identify the best ways of performing their tasks. He was able to achieve a 300 percent improvement in the volume of coal shoveled per worker. These dramatic improvements caused management to quickly adopt scientific management techniques to all possible situations. Maximizing productivity was the goal. Organized labor resisted the scientific methods claiming the procedures were dehumanizing. Taylor was not concerned with the worker and considered him just another piece of machinery used in the production process.

During this time period Henri Gant utilized the scientific methods to formalize the scheduling process. His Gant charts are now routinely used.

2. 1920 Classical School

Classical organizational theories developed cut of a need to find guidelines for managing complex organizations. Henri Fayol was the first to systemize managerial behavior. He believed that scund managerial practice had certain patterns that could be identified and analyzed. Fayol believed management was a skill that could be learned.

During this time period a great deal of the management structure used today was developed. The separaticn of

line and staff organizations, the division of labor (specialization), the span of control (between five and twelve personnel), and the unity of command ideas were all developed during this time period.

3. 1930 Human Relations School

A team of Harvard researchers, led by Elton Mayo, studied the effects of lighting on productivity in the Western Electric, Hawthorne plant in Cicero, Illinois between 1927 and 1932. Two groups of employees were divided from the rest of the work force. A test group was subjected to deliberate changes in the lighting and a control group was kept under constant illumination. As predicted when the lighting conditions were improved productivity increased. But what confused the researchers was that when the lighting was decreased productivity continued to increase. What added to the mystery was that the control groups' productivity began to increase.

What the researchers concluded was that because both groups had been singled out for special attention they developed a group pride that motivated them to improve their performance. This phenomenon has become known as the Hawthorne effect and ushered in the human relations school of organizational theory.

The social environment of employees has a great deal to do with their productivity. Productivity was noticed to change between Monday and Friday. Recognition, participation and sharing increased productivity. The managers approach in dealing with his employees could greatly affect productivity. This caused a great deal of attention to be focused on teaching people management skills.

4. 1940 The Quantitative School

The quantitative school is the beginning of management science as we know it today. During World War II new quantitative techniques were developed for military use to optimize the utilization of scarce resources. After the war these "operations research" techniques were applied to business applications. The basic techniques include linear programming, Monte Carlo simulations, and multiple regression.

5. 1960 The Carnegie School

The Carnegie school was interested in goals. This included how goals were formulated and how decisions got made.

6. 1975 Contingency Management

In the mid 1970's an effort began to reconcile the differences between the various management schools of thought. The contingency school believed that there is no one best way. One must thoroughly analyze the situation and pick the method that best applies. It became evident that an organization is not a closed system and that its environment can greatly influence its future. The contingency school began to merge the social system with the technical aspects of the organization.

Since this time period the goal of managers has been to develop a "systems school" that is sophisticated enough to integrate the various managerial theories together.

B. ORGANIZATION MODELS

The second phase of Rigo's approach to MSS development requires a survey or examination of the current

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organizations' situation. This examination of the organiza-
tional relationships, roles and responsibilities, and the
organizations' environment is commonly called an organiza-
tional analysis.

There are many reasons to analyze an organization.   It
may be to determine the current status of operations, to
predict the future or to try to understand what caused a
problem in the past. A common method of analyzing an organi-
zation is to build a model of the organization.   Models
provide guidance about where to look to diagnose organiza-
tional problems.

Models can be either implicit or explicit.   Implicit
models are often carried in the managers head and can be
subjective and biased.   If the model is implicit, managers
working in a team are not always sure if they are working
from the same model and, therefore, if they have the same
goal in mind.   An implicit model cannot be analyzed to
examine it for weaknesses or omissions. Explicit models are
written down and accepted by the individuals utilizing them.
Once a group accepts the model it is easier to work as a
team to solve a problem.   An explicit model minimizes
discussion about what is the problem and gets right to
solving the problem.   It is therefore wise to have an
accepted explicit model of an organization to carry out a
thorough analysis.

Everyone has his own perception or model of an organiza-
tion based on his experience and background.   This section
will discuss two organizational models used to analyze an
organization.   These models are the Open System model and
the Network model. The Open System model will be briefly
discussed and the Network model will be described in more
detail. The Open System model can be used when time for an
analysis is limited or when an in-depth analysis is not
required.   The Network model is more detailed and will
produce a thorough understanding of the organization.

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1. The Open System Model

An open system is defined as a system that can be affected by its external environment [Ref. 10]. This differs from a closed system where the system is isolated, or closed, from its environment. The open system has interactions with its environment. There is an exchange relationship. The Open System model relates some basic components of an organization with the environment of the organization. Figure 3.1 is a representation of the Open System model.

The model shows that the various components interact with each other and the organizational environment. To perform an organizational analysis using this model one first determines the various variables that make up each component. Next, the components are analyzed in pairs to see if they relate well to each other and the environment. If they do not relate well that is where changes need to be made in the organization.

2. The Network Model

The Network model provides a tool for a thorough organizational analysis [Ref. 11: pp. 70-94]. The model divides an organization and its environment into eight components. These components are related as shown in Figure 3.2.

In this model organizations are conceived as numerous interrelating groups of people. These groups are both formally structured, such as divisions, or task teams as well as informally structured, such as coalitions or personnel friends. A description of the various components and questions to ask about each component during an analysis follows.

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┌─────────────────────────────────────────────────────┐
│                    ENVIRCNMENT                       │
│                                                      │
│   ECONOMICAL         POLITICAL       GEOGRAPHICAL     │
└─────────────────────────────────────────────────────┘
```
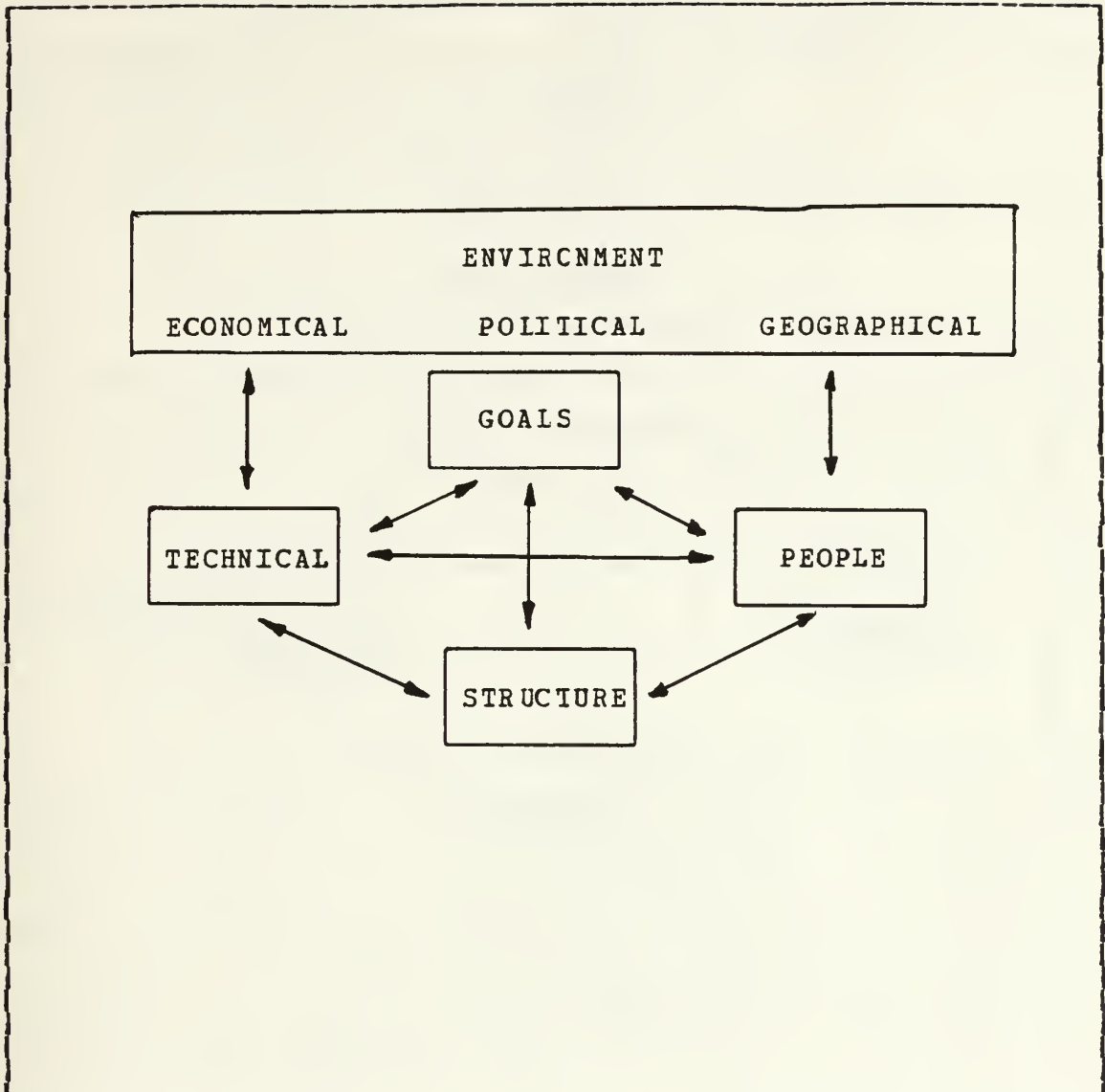
Figure 3.1   The Open System Model A Tool For
            Organizational Assessment.

a. Input

        The inputs of the organization consist of its
history, environment, and resources it requires to conduct
business.

        History analysis should examine the economic,
political, and cultural forces which have acted on the
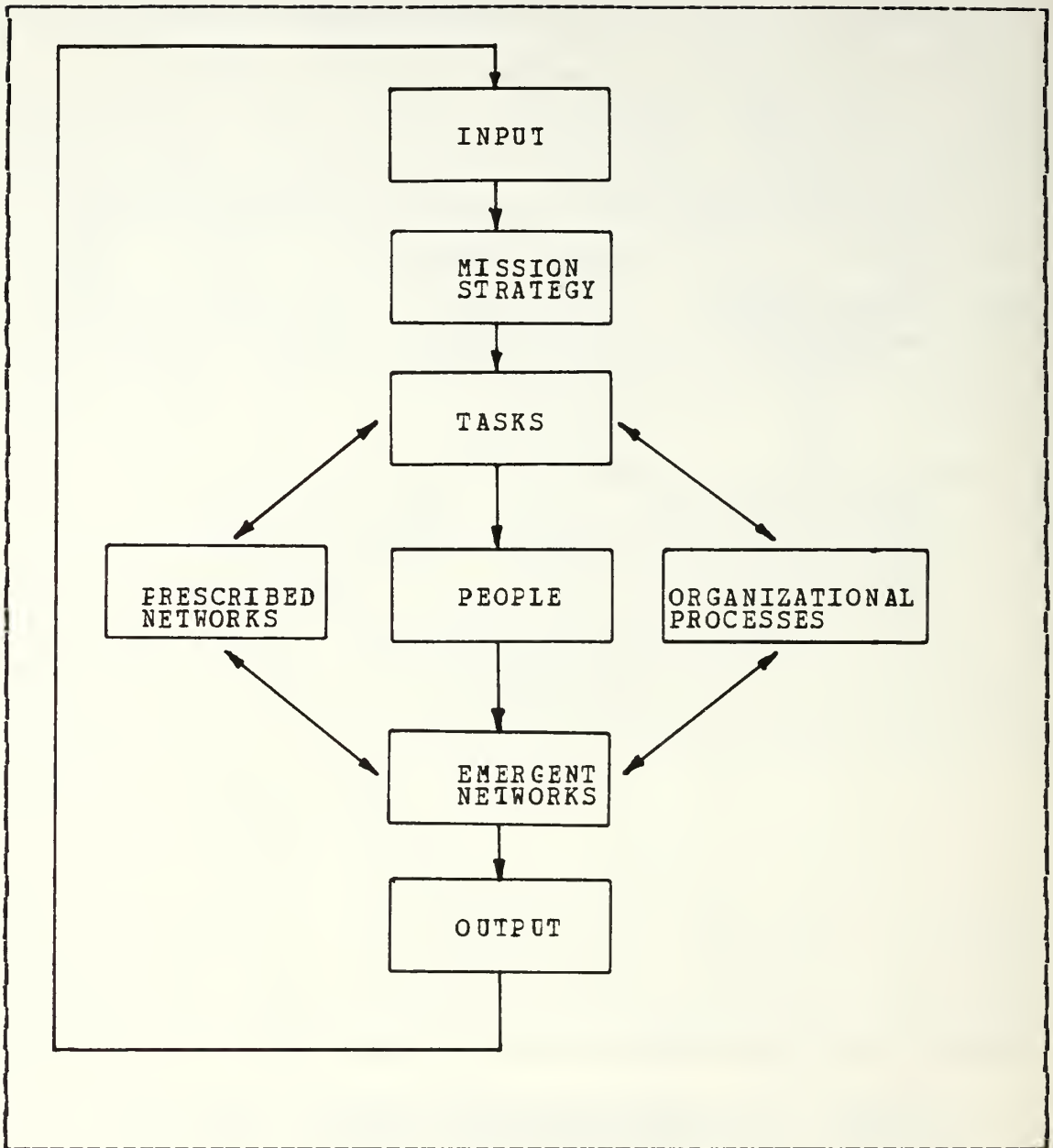
Figure 3.2   The Network Model A Tool For
Thorough Organizational Analysis.

organizaticn in the past.   Analyzing the history of an
organization can uncover material which may help explain why
things are the way they are tcday and also help predict the
future.   Be sure to check that previous decisions have not
been made using a shcrt term perspective.

An organizations environment can provide both opportunities and constraints. When addressing the environment it is good to ask such questions as:

1. Are managers ignoring the environment?
2. When should the organization respond to the environment?
3. What is the organization dependent on?

An organization is usually dependent on the resources it requires for production. Resources can consist of various materials such as equipment, people, space, location, reputation, and goodwill. The assessment of resources should detail how large the resource base is, how the organization uses its resources, and the reputation of the organization.

b. Mission/Strategy

The organizations' mission is its reason for being. Determine if the organization is doing what it was designed to do or has it gotten sidetracked. The organizations' strategy is its approach to carrying out its mission. Verify that there is an explicit strategic plan be it formal or informal. See that the strategic plan matches the environment. Determine if the organizations' management is supporting the strategic plan.

c. Tasks

Tasks are the specific activities which the organization performs in order to carry out its mission and strategy. Tasks can be analyzed along three dimensions. Task interdependence, or how the goods or services are combined into a final product, can determine how sophisticated a MSS is required for production. Three types of task interdependence have been identified. Pooled tasks, where

tasks are carried out independently and then pooled together require the least sophisticated communication network. Sequential tasks, that is tasks that must be accomplished in a particular order, do require a coordination effort to see that the tasks are running smoothly. Reciprocal tasks must be done simultaneously with feedback between the tasks. This type of task interdependence requires the most complete information system.

Another dimension of tasks to analyze is the task predictability. This can be described as the number of unexpected tasks that are encountered in a particular timeframe.

The last dimension is how difficult are the unexpected tasks to accomplish. The analysis of the organizations' tasks should determine the degree of task uncertainty. This uncertainty will influence how the people are selected, the types of prescribed networks and the organizational processes that are required for the organization.

d. Prescribed Networks

Prescribed networks are where the organizational structure is analyzed. The classic organizational structures are function, product, geographic area, and matrix. These structures must be analyzed to see that the structure is right for the effort being performed. The MSS requirements vary for each type according to the type of coordinating mechanisms utilized. If formal rules and regulations are thoroughly laid out less information is required to change hands to do the job. The more complex the coordination required the more sophisticated the information system required becomes.

e. People

There are two main factors that determine how people operate in an organization. These factors are: 1) What motivates the people to perform their tasks? and 2) How do they relate to the leadership of the organization?

People are motivated to perform for many reasons. The common reasons are pay, promotion, praise and a personnel sense of well being. It must be understood that an MSS must be designed to monitor the parameters that motivate the individuals involved and that a persons performance may be modified by the type of data recorded by the MSS.

Leadership should be analyzed to see that they are utilizing professional management techniques. The style of management should also be investigated. Management style can be grossly simplified to either mechanistic or organic. Mechanistic is very structured and rule oriented where organic style is more team oriented with direct contact, shared duties, and a less rigid structure.

f. Organizational processes

Organizational processes are how people carry out their tasks in the organization. It involves communication, control, problem solving and rewards.

Of importance here is the control process. There are basically two types of control processes. They are error catching and problem solving information gathering. An MSS developed using a problem solving information gathering control process permits the organization to learn from its mistakes and make improvements. This type of MSS is more developmental.

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g. Emergent Networks

Emergent networks are informal structures that have developed as a result of human interaction. Emergent networks need to be examined to see if they accomplish anything and who is linked to whom. In organizations that have a rapidly changing environment emergent networks are required to collect and process information that cannot be done quickly enough through formal channels.

h. Outputs

There are many factors that constitute an organizations output. The product or service quantity, quality, and cost are only one aspect of an organizations output. Other criteria can be adaptability, flexibility, job satisfaction of employees, growth or just survival.

After all of these components have been described, the components must be analyzed simultaneously to see how well the components work together. The interrelations of the components of the organization and how well these components fit with the organizations environment must also be analyzed. This analysis should be conducted simultaneously along three perspectives: technical, political, and cultural. Technical refers to the various types of structures used in the organization. Political refers to how and by who power is utilized in the organization. Cultural refers to the social interactions of the organization.

The analysis is conducted by answering the following four key questions:

1. How well are the parts of the organization aligned with each other for solving the organization's technical problems?

2. How well are the parts of the organization aligned for solving the organization's political problems?

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3. How well are the parts of the organizaticn aligned
    for solving the organization's cultural problems?
4. How well aligned are the three subsystems of the
    organization, the technical, political,and cultural?

C. IN SEARCH OF EXCELLENCE

A great deal of informaticn concerning current manage-
ment philosophy can be found in In Search of Excellence by
Peters and Waterman. Although written for the business
community the points made apply equally well to a
government/military bureaucratic organization. MSS's need
to be designed such that they support these effective
management practises.

Innovative companies are defined as those companies
being "especially adroit at continually responding tc change
of any sort in their environments". [Ref. 12: p. 12] Using
this innovative definition, and some standard financial
measures of return, excellent companies were calculated and
researched to discover what made them excellent.

Using personal examples, dccumented reports, and simple
catch phases Peters and Waterman described eight pcints
which they have deterrined make excellent companies. These
eight points are:
1. A bias for action
2. Being close to the customer
3. Allowing autoncmy and entreprenuership
4. Creating productivity through people
5. Being hand-cn and value driven
6. Sticking to the knitting
7. Having a simple form and a lean staff
8. Being simultaneously loose and tight

What is different about the data is that there is a lot
of meat in the material. Simple facts that anyone can use

to develop an excellent company. Peters and Waterman are the first to admit that their findings are not startling. Most appear to be common sense. But they show that most companies do not live by these simple rules. Excellent companies do. Excellent companies are committed to thier people, they have a preference for action and they are intense about what they do.

The eight points that have been determined to make excellent companies will now be discussed in the Navy environment.

1. <u>A Bias for Action</u>

A bias for action is an obvious requirement for an organization to be excellent. We all want to feel we are action oriented. There are three ideas brought out that create an atmosphere for a bias for action. Chunking, or keeping teams small, make the organization one that fosters experimentation, and keep things simple. By observing these rules one can create an environment that fosters action.

Studies have shown that optimal group size for performance to be about seven. Working group size must be kept small enough that meaningful work can be accomplished.

The bureaucracy of the Navy does not allow for quick turn around time. Navy tradition causes change to come slowly. This can be good or bad. By being slow or careful you don't make a lot of mistakes but you don't win any races either. Not being able to experiment and test something quickly is a problem.

To be able to simplify a problem by breaking it down into a series of simple matters is an art required for action. Government regulations are not an example of this. Nothing impedes progress more than the rules and regulations laid down by most government agencies.

2. Being Close to the Customer

Being close to the customer is hard to relate to
military projects on an overall basis but something that is
done all the time.   Sponsors or your immediate boss can be
considered your customer.   Three areas need to be addressed
here: service, quality, and listening to the users.   All
seem obvious and all are vital for an organization to main-
tain an edge on the competition.

An image of quality service is vital to an organiza-
tion.   IBM has built its whole organization based on service
to the customer. Everyone expects quality. Sponsors expect
quality in service and reports.   What makes someone stand
out is the timing.   Were you able to meet or beat the
schedule. Close communication, keeping them informed, gives
you higher visibility such that they will think of you first
when they have another project.   Peters and Waterman
stressed that to maintain a high level of service, quality,
and listening to the users requires constant feedback,
constant updating, to see how you are doing. This keeps you
one step ahead. This is communication.   Being close to the
customer is communication.

3. Allowing Autonomy and Entrepreneurship

Allowing autonomy and entrepreneuralship does not
come easy in the Navy organization.   The team player is the
one who advances.   But if you look closely it is the team
player who stands out a little.   Peters and Waterman bring
out the idea of a "champion" for each cause or project.   In
the military world this gets into the political aspect of a
project.   Without a sponsor or champion supporter your
program will probably be rejected.   Champions get champion
supporters from past efforts. If you have shown you can get
something done you will be given more leeway on future
programs.

4. Creating Productivity through People

The success of an organization depends on its
peoples attitudes. If the people feel good about the organ-
ization they will produce more. Productivity through people
has to be the most important factor in developing an excel-
lent company. Showing respect for the individual, trusting
the worker, and providing both monetary and nonmonetary
incentives for the workers increases productivity. Keeping
a team or crew motivated will greatly increase their output.
People are the Navy. Bureaucratic delays causing a delay in
receiving awards or advancement reduces the impact of doing
a good job. The feedback must be immediate. A leader can
make a big difference in motivating a team. If the team
believes in the leader they can do wonders, if not, they
become just another bunch of guys. If you can make the
workers feel like a part of the organization, keep them
informed, and keep the tasks they perform in small manage-
able packages productivity will increase.

5. Being Hands-on and Value Driven

A companies success depends on how well it brings
out the strengths of its workers and the appeal its value
system has on the workers. Excellent companies are hands-on
and value driven. There are seven basic values dominant in
excellent companies. These seven values are:
1. A belief in being the best
2. A belief in the importance of the details of execu-
    tion
3. A belief in the importance of people as individuals
4. A belief in superior quality and service
5. A belief that most members of the organization should
    be innovators

6. A belief in the importance of informality to enhance communication

7. A belief in the importance of economic growth and profit.

Excellent companies have well defined value systems. Excellent companies rely on many techniques to influence day-to-day behavior. One important technique is the elaboration of socially integrating myths.

6. Sticking to the Knitting

Sticking to the knitting means do what you know best. Excellent companies do one thing and do it well. Some general comments about sticking to the knitting that are interesting follow. Most diversifications go wrong. Diversification is a basis for stability through adaptation but rampant diversification does not pay. Organizations that diversify but stay in their own area out perform all others. Test a new area carefully, if it fails, end the experiment quickly. Virtually all growth in the excellent companies has been internally generated.

7. Have a Simple Form and a Lean Staff

Excellent companies keep their form simple and their staff lean. To make an organization work everything must be kept simple for the numerous people who must make things happen. This is one area that the government needs to improve in.

An organizational system needs to respond to three basic needs. These needs are "A need for efficiency around the basics, a need for regular innovation, and a need to avoid calcification by ensuring at least modest responsiveness to major threats." [Ref. 12: pp. 314-315]

8. Be Simultaneously Loose and Tight

The factor called simultaneously loose and tight properties is probably the hardest to identify with but still quite practical. It is basically the co-existence of firm central direction and maximum individual autonomy. The following statements try to describe this property. Excellent companies live by their values. If you are making a product with quality you don't have to make it twice. The rules of an excellent company are positive. They focus on people. The average worker is expected to contribute. Excellent companies don't really have better five-year plans or in some cases little detail to their long range plan, but they have a firm set of values. People who head excellent companies keep things simple.

Three general themes that keep coming back are worth repeating. They are: 1. keep it simple, 2. keep communication lines open, and 3. respect people.

IV. ELECTRONIC WARFARE SYSTEM SUPPORT LABORATORY DESCRIPTION

In Chapter II it was shown that in order to develop an effective MSS one must have a thorough understanding of the current situation. In Chapter IV the EWSSL will be described using the Network organizational model discussed in Chapter III. See Figure 3.2.

A. INPUT

1. History

The EWSSL had its beginning in 1969 when several engineers were tasked to test a new deceptive electronic countermeasures (DECM) system. The engineers developed a closed-loop radar range tracking loop to test an ECM technique in the DECM system. Soon after several other simulations were developed including angle tracking loops and the "laboratory" became known as the Tactical Environment Simulation (TES) laboratory. A major boost in capability came in 1974 when the TES laboratory was tasked to test the Dual Mode program, a joint Navy/Air Force DECM system. During this time more closed-loop simulations were developed and an open-loop radar simulator called the Multiple Environment Simulator (MES) was developed. As more and more tests were conducted more assets were developed.

With the advent of software reprogrammable DECM systems it was recognized that a facility to verify software changes was required. The TES was seen as the logical location for this facility. "Hot benches" used to power up, acess and modify system software, and input threat stimulus into the reprogrammable DECM systems were constructed. With this expanded role the laboratory was renamed the EWSSL.

2. Environment

As part of a U.S. Navy facility the laboratory must deal with a very bureaucratic atmosphere. There are formal rules, regulations, and procedures for just about everything. These regulations while providing a very structured operation create a large amount of paper work and slow down operations. This environment is accepted and no one really tries to change it.

The EWSSL is a nonprofit organization providing a service to Navy, Air Force, Army, and private contractors. As such it interfaces with numerous types of organizations. 95 percent of the work is performed for vy developmental DECM programs.

Related work is performed in facilities at the Naval Weapons Center (NWC), China Lake, California and the Naval Air Test Center (NATC) Patuxant River, Maryland. Because of this a TRI center committee consisting of EW personnel from NWC, NATC, and PMTC was formed in 1982. The committee holds periodic meetings to coordinate the EW activities of the three centers. Data exchanged during these meeting provide an information base to help in making long range plans.

The EWSSL's distance from Washington creates a communication barrier. This becomes a political disadvantage when data must be exchanged rapidly in response to sponsors questions concerning ongoing programs. Familiarity is difficult to achieve with Washington sponsors because of the distance and periodic traveling to Washington is required to keep programs visible and to determine what is going on.

3. Resources

The EWSSL's prime asset is its laboratory facility. The laboratory occupies 4000 square feet of space in

building 35, the EW building, at PMTC. In 1984 the labora-
tory completed an expansion program that almost doubled its
useable laboratory space. The entire facility is on
computer flooring with soundproofing and adequate air
conditioning.

A new Digital Equipment Corporation Vax 780 digital
computer was installed in the laboratory in 1985 as the
laboratory's host computer. The Vax 780 is the largest of
the laboratories five digital computers. The laboratory has
contracted for the development of a new state of the art
open-loop threat generator called the Advanced Multiple
Environment Simulator (AMES) to be delivered during 1985.
Also under contract is a new threat radar simulator that
will be delivered in stages over the next several years.

Currently available for testing are four closed-loop
threat radar simulators that model selected threat radars
and are used to measure the effectiveness of DECM systems.
The existing open-loop simulator, the MES, models emitter
parameters of threat systems such as airborne, land-based,
and naval radars as well as the command guidance of missile
systems.

Four hot benches provide a software reprogramming
capability for two radar warning receivers (RWR)s and two
DECMs.

Besides the specific systems mentioned the labora-
tory utilizes a large quantity of sophisticated and expen-
sive commercial, as well as custom built, laboratory test
equipment. These equipments encompass the range from voltm-
eters and oscilloscopes to spectrum and network analyzers to
radar range delay generators.

The ability to operate this equipment does not come
easy. A staff of engineers and technicians is available to
operate and repair the existing equipment. However, the
equipment is merely a tool to perform the primary function

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of test and evaluating RWR and DECM systems. Engineers that
conduct the test and evaluation are the laboratories biggest
human resource.   This ability can only be gained from years
of experience.

The laboratory has a reputation for getting the job
done on time and within budget.   The EWSSL can provide the
user with quick reconfiguration of laboratory equipment or
generate a new capability as required.   These capabilities
and equipments make the laboratory one of the top three
threat simulation facilities in the country for the test and
evaluation of tactical aircraft RWR and DECM systems.

B. MISSION AND STRATEGY

The EWSSL is located in the Electronic Warfare Systems
Test Laboratory (EWSTL) branch.   The mission of the EWSTL
branch is to provide state of the art laboratory capabili-
ties which serve as the Navys' principle facility for
airborne EW system development testing, countermeasure tech-
nique development and test, test and evaluation of primary
EW systems, suite integration and testing, and software
reprogramming support.

The strategy to accomplish this mission is to:
1. Design, develop, and maintain tactical environment
    simulations with open and closed loop representations
    of threat radars with design concepts based on elec-
    tronic intelligence and theoretical projections and
    employ this capability for testing EW systems and
    suites.
2. Provide a focal point for Navy development and fore-
    cast of threat radar simulations including interface
    and coordination with other military agencies and
    laboratories.   Serve as a prototype development

center for advanced threat radar simulator installations and as a data comparison point for laboratory, chamber, and flight test data correlation.

3. Develop work stations for EW systems and suites and operate laboratory facilities to support performance evaluation, Fleet responsive problem investigation, software maintenance, and system integration.

4. Design test plans and conduct EW system integration testing to assure system-to-system, suite, and platform interface compatibility.

5. Define requirements and provide laboratory equipment and computer facilities for real time control of simulations and for hosting application programs, system models, and support tools related to EW system testing, user data file changes, and software maintenance/ test and configuration management.

6. Provide development support, system analysis and coordination focus for test and evaluation of EW systems as assigned.

7. Develop engineering expertise for analysis of foreign weapon systems and interface closely with intelligence, Fleet, and sponsor agencies to define state-of-the-threat capabilities for reprogramming user data files and updating laboratory simulations.

8. Provide project management for projects assigned to the Branch.

This mission and strategy has developed over time. Program sponsors determine the mission based on their projected needs. Laboratory managers provide recommendations to the sponsors for long range planning based on their analysis of the changing EW environment.

C. TASKS

The tasks that personnel in the EWSSL perform can be divided into four main areas. These areas are planning and operations, simulator development, testing, and maintenance.

1. Plans and Operations

Laboratory managers perform the planning and oversee the daily operation of the EWSSL.

Planning is focused on yearly efforts. However, general planning is carried out for five years in accordance with the Five Year Defense Plan (FYDP). Yearly planning is based on EW systems being developed and their scheduled time for testing in the EWSSL and on threat simulator development schedules. The threat simulators are developed to test specific functions of EW systems being developed. The simulator must be completed prior to the time the EW system is being tested in the EWSSL. This involves tracking the development schedules of all Navy tactical aircraft EW systems, and monitoring those of the Air Force and Army to see if the EWSSL can support any of their programs.

EWSSL scheduling must be controlled such that assets are available and functioning. This involves configuring the simulator equipment, computers, and personnel required for the test. There are numerous ways the systems can be configured and tested. Modularity has been designed in so any one of four computers can control any one of five simulators and be connected to any one of four hotbenches individually or in groups of up to three. Isolated tests can be conducted on a unique EW system if power and interface requirements are detailed far enough in advance. There is not enough EWSSL personnel to operate all the equipment simultaneously so this factor must also be accounted for in the scheduling of tests.

2. Simulator Development

The task of simulator development involves either the actual design, fabrication, and testing of simulator hardware or the monitoring of a contractor who is actually performing the work. Until 1982 the EWSSL performed all its own simulator development. Since that time private contractors and other Navy facilities have been utilized to develop major simulators.

The development of simulator hardware is very complex. First a thorough understanding of the radar to be simulated is required. This information is obtained, to the degree available, by interfacing with the Scientific and Technical Intelligence Liaison Officer (STILO) office of PMTC. If the STILO does not have the information his office searches available data bases and makes inquires to the Naval Intelligence Science Center in Washington D.C. for the information.

When the system parameters are decided the hardware design is performed. Information sources for design techniques can come from textbooks, various technical journals, equipment sales representatives, and discussions with other engineers. Next, parts are ordered, the system constructed, tested and documented. Testing and documentation usually take more time then originally allocated. Documentation must consist of operating manuals, discussion on the theory of operation, wiring diagrams, and parts lists. Not all documentation is available for all EWSSL hardware. All documentation is filed in cabinets in the EWSSL by simulator.

Monitoring a contractor effort involves reviewing the contractor design, development plans, fabrication techniques and overseeing the testing and integration into the EWSSL. Contractor documents that must be reviewed and filed include the program plan, specifications, test plans and test reports, status reports, and operating manuals.

3. Testing

Testing involves test planning, conducting the test, and documenting the results.

During test planning engineers from the EWSSL either write the test plan from analysis of the development specifications of the EW system to be tested, or assist the EW system developers in performing the task. This effort involves coordination of EWSSL assets and personnel to assure availability, scenario development based on EWSSL capabilities and system requirements, and assuring hardware interfaces are compatible.

Actual test performance involves making measurements of various EW system parameters utilizing simulator hardware or test equipment hardware of the EWSSL. Simulator hardware must be calibrated and actual parameters documented. Simulator configuration, both hardware and software, and the scenarios utilized must also be documented. All data is recorded by hand into log books for inclusion in the final report. The final report involves a thorough description of the test configuration, the test results, and, if possible, implications of these results.

Testing on a particular system may last days, weeks, or even months with laboratory operating hours extended from a normal eight hours up to twelve hours. Many people can be involved simultaneously. They include simulator hardware and software operators, test conductor, EW systems engineers both military and contractor, and sponsors monitoring the test.

Test reports are transmitted to EWSSL users as a letter report, a technical memorandum, or as a data package. Laboratory personnel make sure that the data packages are delivered as soon as testing is completed but formal reports take a great deal longer.

4. Maintenance

All equipment in the EWSSL must be maintained. All computers are under maintenance agreements with the contractors that built them. Certain test equipment must be calibrated routinely, usually every six months by the PMTC calibration laboratory. This equipment must be scheduled for calibration such that it is not being calibrated when it is required for testing. A great deal of the equipment in the EWSSL is plant property class III material and must be inventoried every three years. Custom built equipment is calibrated prior to each use.

Scheduled and unscheduled maintenance is performed by electronic technicians.

D. PRESCRIBED NETWORKS

The organizational structure of PMTC is the dominant network effecting the EWSSL. PMTC utilizes a functional structure to divide the work processes. In 1984 PMTC was reorganized into the organization shown in Figure 4.1. At this time EW was given greater control by the creation of its own directorate. Prior to 1984 EW existed as a division within the Weapons Evaluation directorate. The EW directorate is further subdivided by function as shown in Figure 4.2. The EWSSL is located in the EW division where 90 percent of the program and personal interactioins take place. The EW division organizational chart is shown in Figure 4.3.

Over 95 percent of the EWSSL's development and testing funding comes from NAVAIR. Until 1985 NAVAIR was one of six subordinate commands within the Navy Material Command. With the dissolution of the Navy Material Command NAVAIR now reports directly to the Chief of Naval Operations. The NAVAIR organization follows a concept employing functional
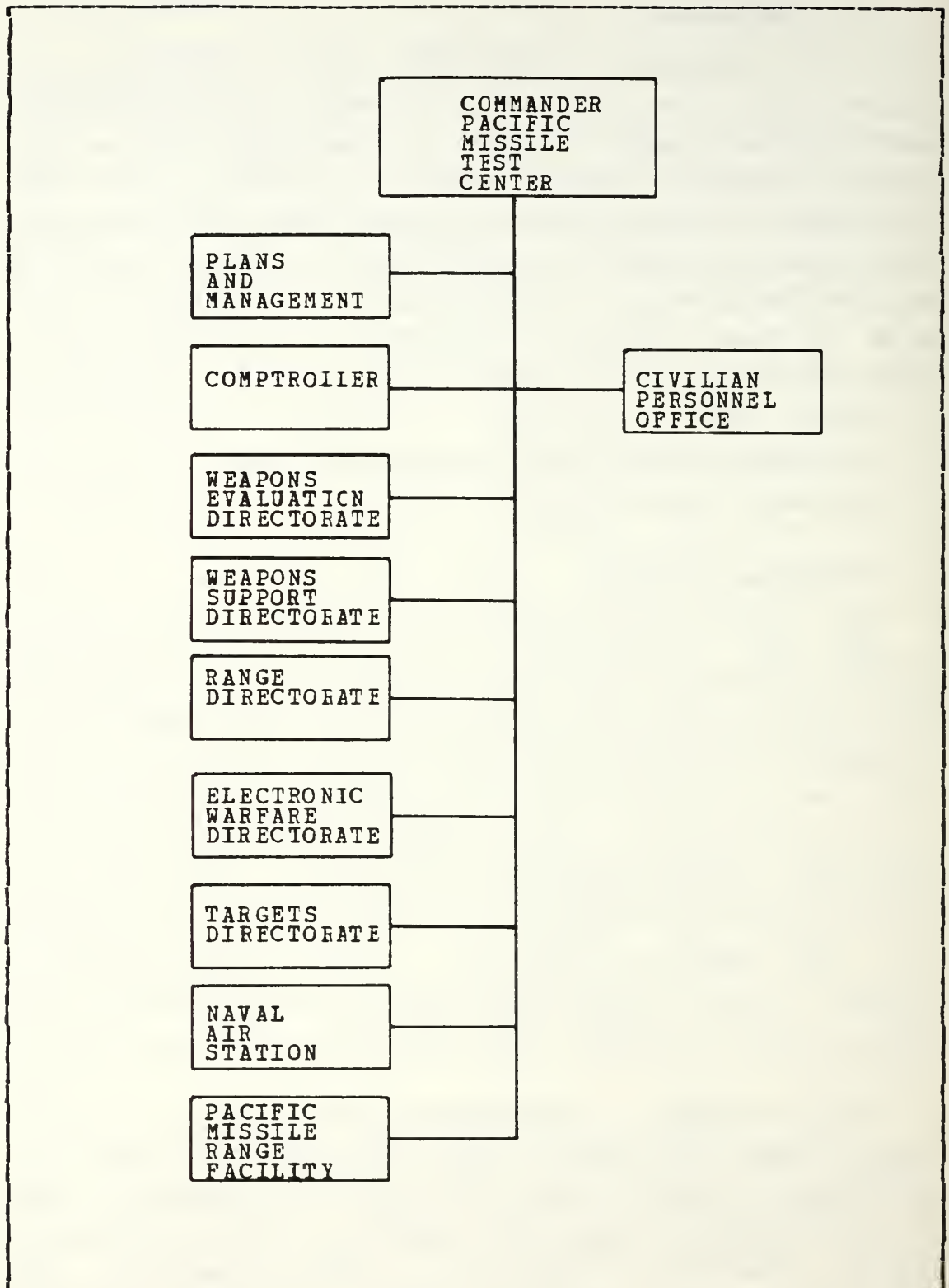
Figure 4.1   PMTC Organization After 1984 Reorganization.

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                    ┌─────────────────┐
                    │ ELECTRONIC      │
                    │ WARFARE         │
                    │ DIRECTOR        │
                    └─────────────────┘
          ┌──────────────────┼──────────────────┐
    ┌───────────┐      ┌───────────────┐      ┌───────────┐
    │ELECTRONIC │      │ ELECTROMAGNETIC│     │ELECTRONIC │
    │WARFARE    │      │ DIVISION      │      │WARFARE    │
    │SYSTEMS    │      │               │      │COMPUTER   │
    │DIVISION   │      │               │      │RESOURCES  │
    │           │      └───────────────┘      │DIVISION   │
    └───────────┘                             └───────────┘
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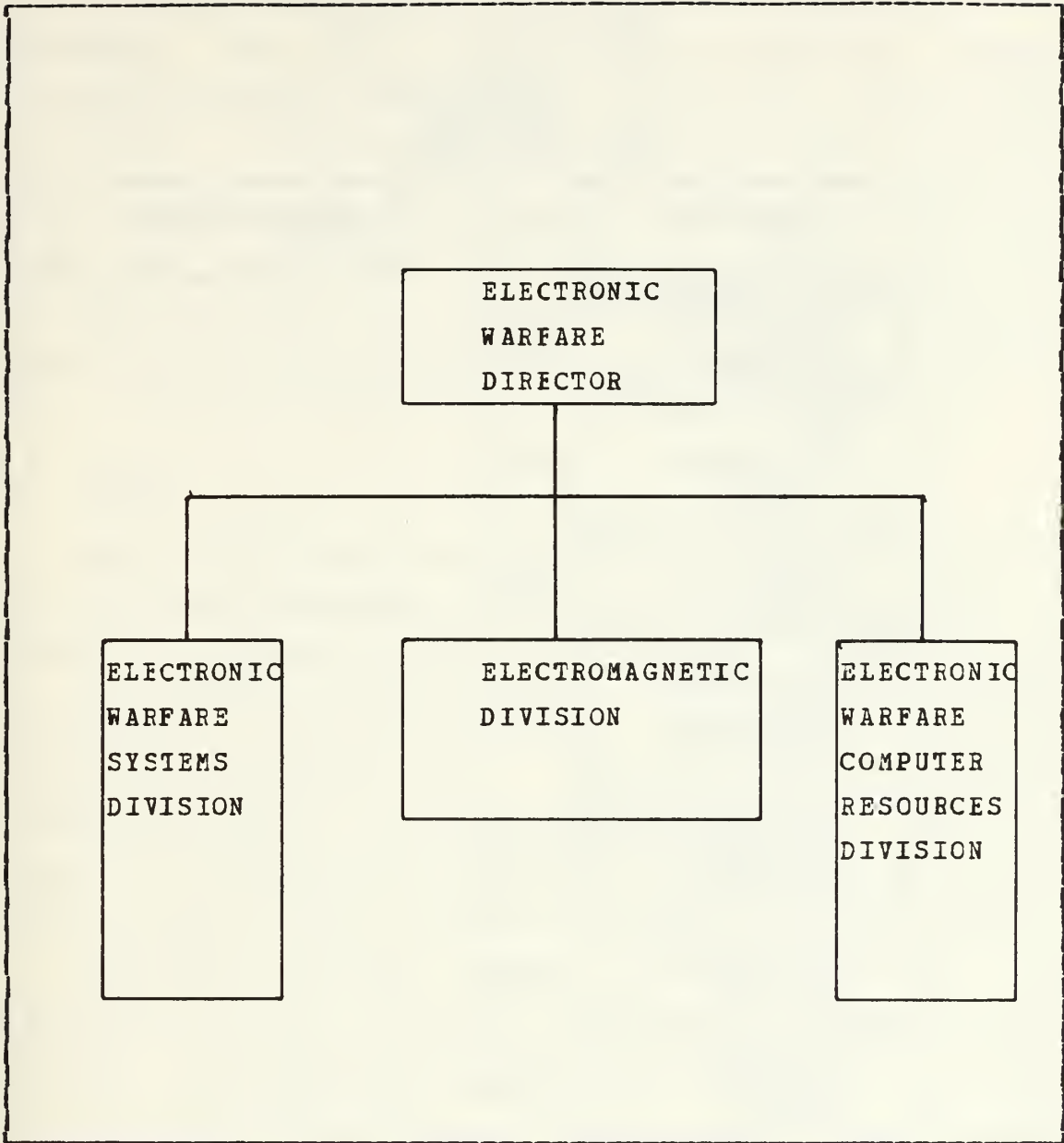
Figure 4.2   Electronic Warfare Directorate
          Created During 1984 Reorganization.

and product organizations with line and staff organizational
structures.   In addition,   program management organizations
are superimposed on the basic functional organizaticn for
prosecution of selected priority projects.   An organization
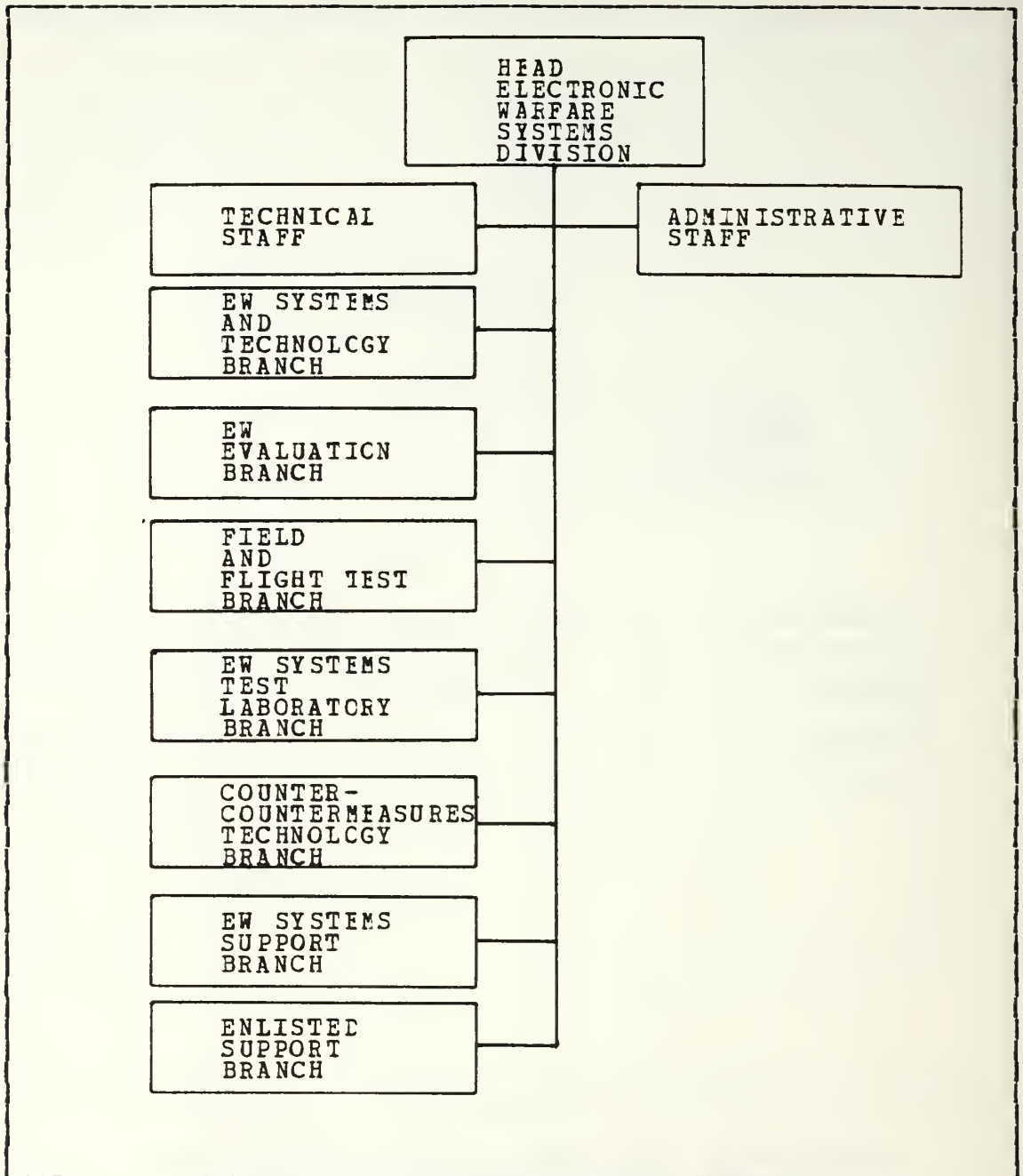
**Figure 4.3   Electronic Warfare Systems Division
Organization Chart.**

chart of NAVAIR is shown in Figure 4.4.   One such program
management organization is Program Manager,Air (PMA)   253

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Reconnaissance,Electronic Warfare Systems, Operational, Navy
(REWSON). PMA 253 is the EWSSL's financial sponsor.
Technical responsibility for the EWSSL lies within NAVAIR
code 5492. 5492 is also responsible for prime EW system
development. NAVAIR code 5332 controls the EWSSA operations
which oversees the software testing performed in the EWSSL.
These 5000 level codes are buried deep within the Air-05
function of NAVAIR. A selected portion of the organiza-
tional chart of AIR 05 may shed some light on this interac-
tion. The organizational chart is shown in Figure 4.5.

E. PEOPLE

There are 23 people in the EWSTL branch. Of these 18
are electronic engineers, physicists, or mathematicians. A
secretary, program analyst, and electronic technicians make
up the rest of the organization. All have some college
background. The work here is very technical and requires a
technically oriented staff. Ages vary from 25 to 50 with
experience with the laboratory ranging from one year to 11
years. The staff is very dedicated. The stigma of the lazy
civil servant is very irritating to most of the employees.

Personnel motivation varies between individuals. The
bureaucracy of the civil service does not allow for prompt
rewards. All employees are paid under the General Schedule
system or the Merit Promotion Program. As such it is common
knowledge what most employees are earning (within several
thousand dollars). Pay raises are tied to time in service
and performance.

The leadership styles vary among individuals. A mechan-
istic approach is favored to a degree because of the highly
regimented bureaucracy. The Branch head has had managerial
training whereas the most common situation within the divi-
sion would be where an engineer with no management training
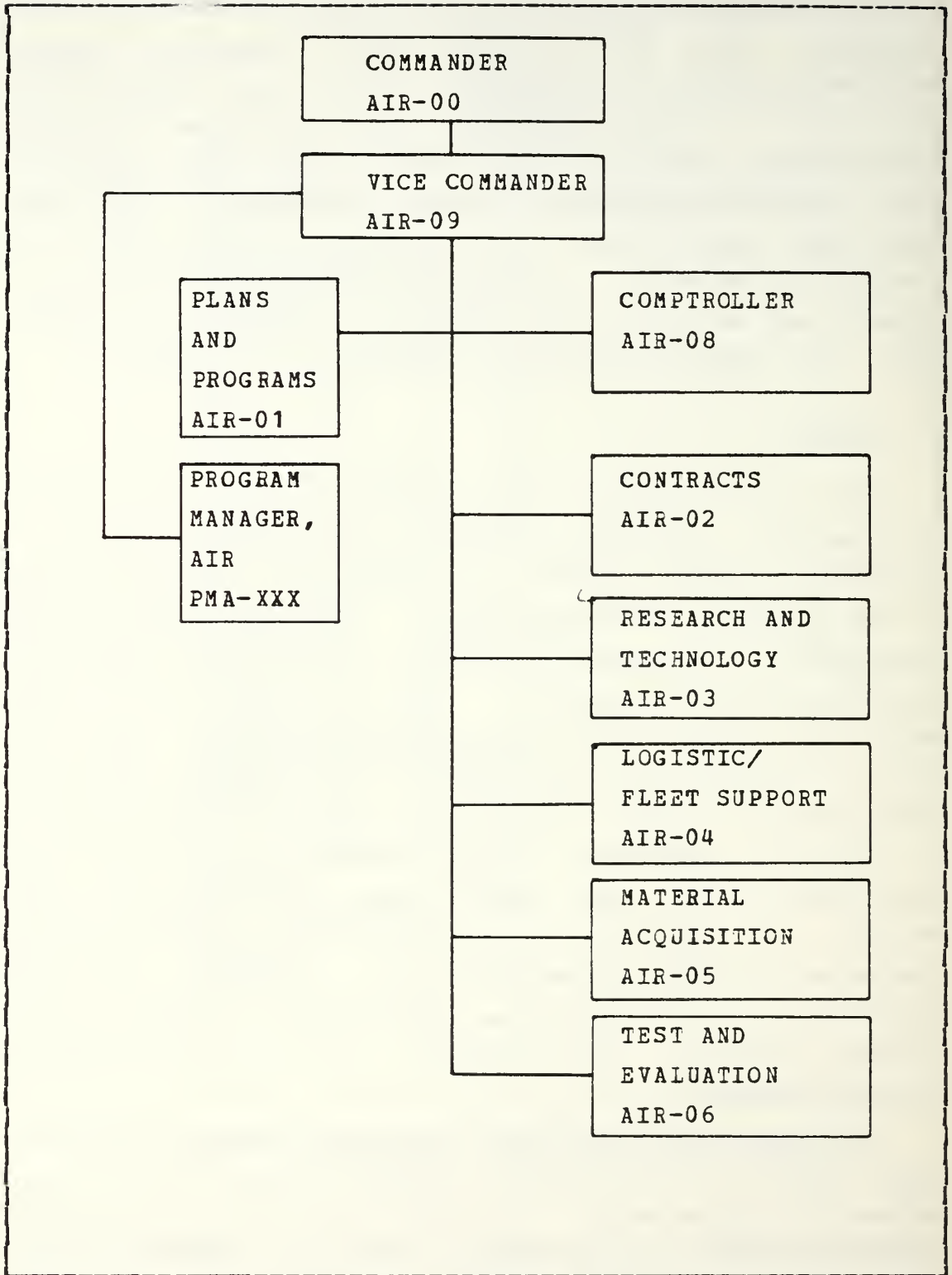has assumed command because of his technical expertise.

Figure 4.4   Naval Air Systems Command
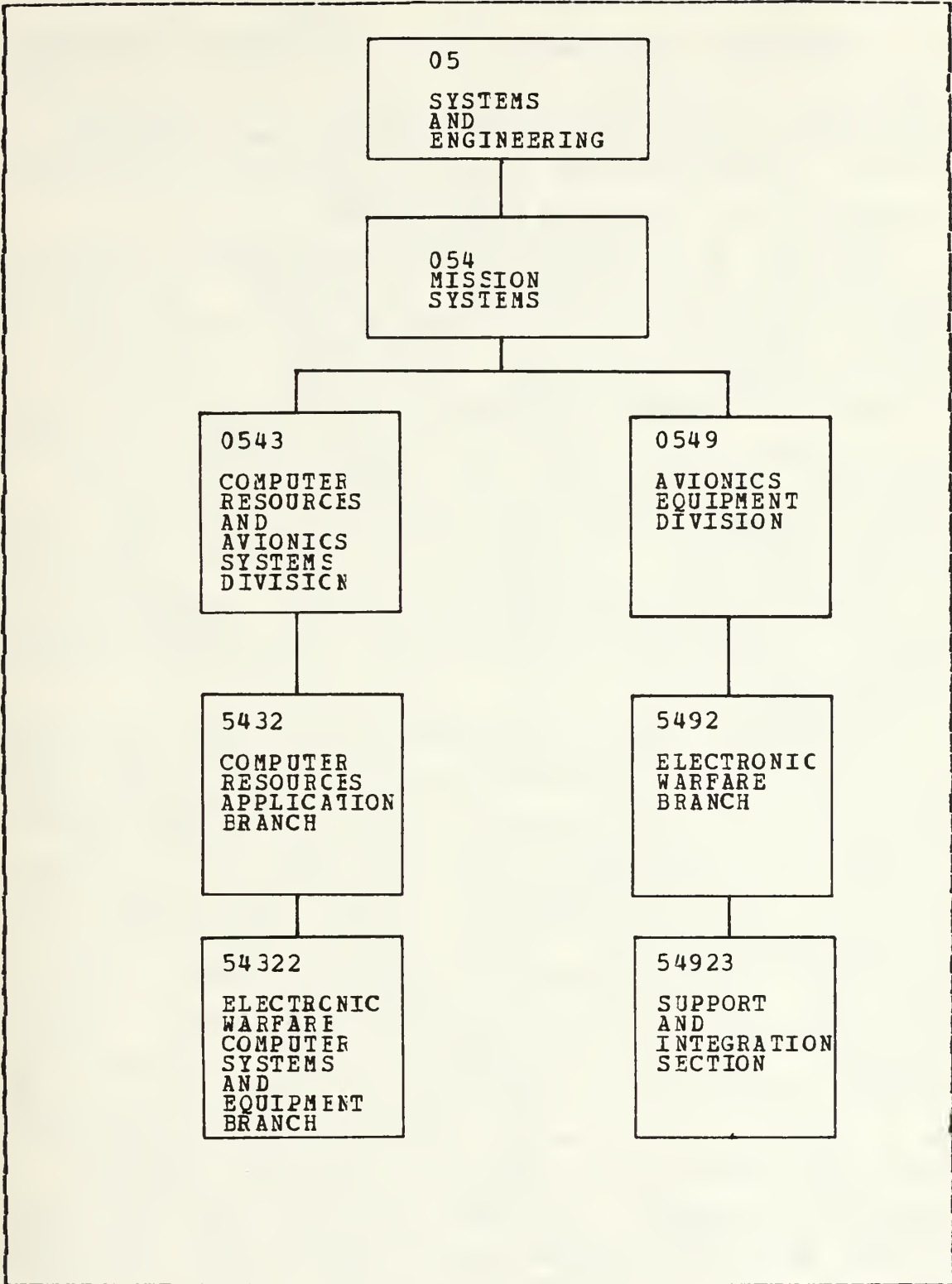Organization Relationships.

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                    ┌─────────────────┐
                    │ 05              │
                    │ SYSTEMS         │
                    │ AND             │
                    │ ENGINEERING     │
                    └────────┬────────┘
                             │
                    ┌────────┴────────┐
                    │ 054             │
                    │ MISSION         │
                    │ SYSTEMS         │
                    └────────┬────────┘
              ┌──────────────┴──────────────┐
     ┌────────┴────────┐           ┌────────┴────────┐
     │ 0543            │           │ 0549            │
     │                 │           │                 │
     │ COMPUTER        │           │ AVIONICS        │
     │ RESOURCES       │           │ EQUIPMENT       │
     │ AND             │           │ DIVISION        │
     │ AVIONICS        │           │                 │
     │ SYSTEMS         │           │                 │
     │ DIVISION        │           └────────┬────────┘
     └────────┬────────┘                    │
     ┌────────┴────────┐           ┌────────┴────────┐
     │ 5432            │           │ 5492            │
     │                 │           │                 │
     │ COMPUTER        │           │ ELECTRONIC      │
     │ RESOURCES       │           │ WARFARE         │
     │ APPLICATION     │           │ BRANCH          │
     │ BRANCH          │           │                 │
     └────────┬────────┘           └────────┬────────┘
     ┌────────┴────────┐           ┌────────┴────────┐
     │ 54322           │           │ 54923           │
     │                 │           │                 │
     │ ELECTRONIC      │           │ SUPPORT         │
     │ WARFARE         │           │ AND             │
     │ COMPUTER        │           │ INTEGRATION     │
     │ SYSTEMS         │           │ SECTION         │
     │ AND             │           │                 │
     │ EQUIPMENT       │           └─────────────────┘
     │ BRANCH          │
     └─────────────────┘
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Figure 4.5   Groups Within AIR-05 Responsible
              For Electronic Warfare Projects.

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F. ORGANIZATIONAL PROCESSES

A great deal of time is spent justifying and obtaining funding to be utilized in the EWSSL. This is nearly a continuous process throughout the fiscal year. Requirements for the justification of funds is based on the Planning, Programming, and Budgeting System (PPBS).

The PPBS is a decision making process for allocating resources used by the Department of Defense. The PPBS has been in use since the early 1960's when then Secretary of Defense McNamara introduced the system. The system is designed to assist the Secretary of Defense in making choices about the allocation of resources among a number of competing programs to accomplish specific objectives of the national defense. The PPBS works as follows. Based on an anticipated threat, a strategy is developed. Requirements of the strategy are estimated and programs are developed to execute the strategy. Finally costs of approved programs are budgeted.

The planning phase of the PPBS begins with the submission of the Joint Strategic Planning Document by the Joint Chiefs of Staff. The Secretary of Defense uses this document to determine requirements which are issued in a document called the Defense Guidance (DG). With the issuance of the DG the Programming phase begins. The services use the DG to develop the Program Objective Memorandum (POM). The POM expresses total program requirements in terms of force structure, manpower, material and cost, to satisfy all assigned functions and responsibilities covered in the DG for a period of five years. The Five Year Defense Plan (FYDP) is the official summary of programs approved by the Secretary of Defense. The FYDP specifies force levels and dollars of major programs and is used as the controling internal working document of the PPBS. The POM provides

rational for changing the FYDP and is the primary means of requesting revision of approved programs as published in the FYDP.

Budgeting is the final phase of the PPBS. It is through the budget that the planning and programming are translated into yearly funding requirements.

This has been a gross simplification of the PPBS but required to introduce the terms POM and FYDP. PMA 253 is the organization that develops the POM that effects the FYDP for the research, development, test, and evaluation (RDT&E) funds of which funding for the EWSSL is one small part. The RDT&E appropriations sponsor is OP 98.

There are three updates to the FYDP during the fiscal year. The times are not exact but within a couple of weeks. They occur just prior to the start of the fiscal year in late september, when the President submits his budget to Congress on January 15, and during the midyear reviews during March. These three times are important because program dollars may be cut at these times. They are therefore good times to be prepared with thorough program justifications.

Planning for the next fiscal year begins with discussions with the sponsor during the midyear review. At this time a FYDP update should have taken place and a good idea of dollars available should exist. The sponsors ideas and opinions can also be used to help generate the next years budget. The budget is presented to the NAVAIRSYSCOM sponsors in the June/July timeframe. The formal document submitted is called a REWSON plan.

The most frustrating process, in the opinion of the EWSSL engineers is that of procuring hardware. There are a great deal of supply rules and regulations that seem to change each time you use the system.

To purchase an item a purchase order stub is filled out.
If the item costs less the one thousand dollars and three
supliers are given along with a priority the item will be
purchased. Priorities are assigned based on need. If the
item costs more then one thousand dollars a set of specifi-
cations must also be included. If the item costs more then
25 thousand dollars an Acquisition Review Board document
providing additional funding data must be included. If the
item costs more then 100 thousand dollars the purchase must
take place through the Naval Supply Center, Long Beach, Ca.
which delays purchase several weeks. If a specific supplier
is required, a "sole source" justification must be done. If
the item is a computer an Automatic Data Processing
Equipment justification must be done. If the computer costs
more then 25 thousand dollars the approval must be obtained
at the NAVAIR level.

Keeping track of individual items turned into the supply
system is very difficult. Currently a manual processing of
the stubs occurs at the division level such that it can be
ascertained that the item is in the system and an estimated
delivery date is given. If that date is passed an inquiry
may be made at that time. Queries before that time are not
allowed.

G.   EMERGING NETWORKS

A great deal of information is gained through informal
human relations. There are numerous factors creating
networks in the EWSSI. The people in the organization tend
top form relationships because of any one or several of the
following criteria: age, sex, GS rating, time at PMTC, or
outside activities. Most interactions are with personnel
within the EWSTL branch but frequently occur with personnel
within the EW division.

Different groups generate different types of information. Secretaries transmit unannounced personnel changes best. Program Analysists transmit upcoming rules and regulations changes and job openings best. New employees provide a broad idea of what is going on throughout the base best based on who has job openings for new personnel and what types of projects are available. Test equipment development information is most readily available from technicians and young engineers. GM-13 and above personnel are more interested in the political aspect of operations. These include personnel and program changes within the PMTC organization and at NAVAIR.

B. OUTPUT

The EWSSL generates several outputs. Data packages and formal reports are generated after each laboratory test and delivered to the laboratory user and the laboratory sponsor. These reports are the most visible output of the laboratory. They provide technical data of the EW system capability and are used by the EW system developer to ascertain whether the system should continue on its development cycle or if modifications are required. These reports can become highly visible within the Navy depending on the size of the EW system tested. As important as the data package is the time required to perform the testing. If the testing took longer then planned the EW system's development could be delayed. Delays can be directly translated to a dollar cost. It is therefore very important that EWSSL personnel or hardware not be the cause of any delay.

Another output is the quality of the threat simulators developed by the laboratory. There are several aspects to quality. Most important is how close does the simulator match the threat. Other aspects are: 1) How easy is the

simulator to use?   2)   How long does it take to calibrate? and 3) How reliable is it?

The EWSSL is known for its easy to use, reliable threat systems. Every effort is made to assure that they match the threat system in every detail known.

Another output closely monitored by the sponsor is how efficiently money is spent and if additional funds are often required late in the year to complete operations. The EWSSL makes sure it properly allocates all funding by the end of the year.

Quarterly reports detailing both technical and financial operations are sent to the sponsor.   A year end report summarizing the years effort and a detailed program plan that outlines the next years activities are sent to the laboratory sponsors once a year.

V. EWSSL MSS REQUIREMENTS

A. INTRODUCTION

This chapter represents the third phase of an MSS development as detailed by Rigo in Chapter II. This is the requirements analysis phase. The information obtained in the organizational analysis of chapter IV will be used to develop the system requirements.

For the requirements determination a decision analysis approach as detailed by Ackoff [Ref. 13: pp. 603-607] will be used. Decision analysis is performed by steps as follows:

1. Identify and prescribe decision.
2. Define decision algorithm or decision process.
3. Define information needed for the decision process.

This means to state your required output, define the process required to achieve the output, and then determine where the information needed for the process is available. This approach is systematic and comprehensive. By Analyzing first the high level tasks and then dividing these tasks into subtasks, a reasonable assurance of completeness can be achieved. The result of the analysis will be a gross design of the MSS for the EWSSL.

The current information system will be evaluated after the required output is determined to see if it can satisfy the requirement.

B. GENERAL REQUIREMENTS

Based on Anthony's framework where managerial functions are broken into hierarchal levels it would seem that this would be the way MSSs are developed also. This is not the

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case. Most MSSs are designed around the functions they are suppose to support, such as marketing, production, or financial. The functions performed in the EWSSL were broken into tasks during the organizational analysis. These tasks fit together in a natural order.

The MSS for the EWSSL will be divided into these three functional areas of planning, operations, and development. The planning system would include the tasks of long range planning, the development of the REWSON plan, task plan, and tracking the overall financial status of the EWSSL. The operations system would provide operational control including the day to day tasks such as scheduling, laboratory setup, calibration, maintenance, record keeping, and report generation. The development system would provide operational control for hardware development.

Developing a MSS does not necessarily mean building a computer controlled system. In fact most of the requirements detailed herein could be met with a manual system and to a degree are. However, the main factor driving the development of this MSS is to be able to respond rapidly in an orderly fashion to the wishes of the Washington sponsors and the PMTC command. In order to achieve this objective a computer system is required.

Numerous computer systems are available that provide a "program management" capability. The problem is that no standard has been agreed upon among the numerous groups that interface with the EWSSL.

No attempt will be made in this thesis to pick the appropriate system as computer capabilities seem to change overnight. Particular attention, however, should be paid to an effort of NAVAIR PMA 253 to integrate their financial system under one computer system. A common computer system between the Washington sponsor and the EWSSL where data could be transmitted electronically would be an ideal situation.

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The NWC's Echo range facility is currently using an Apple Corporation Lisa computer system for some program management functions. Should NAVAIR code 5492 also purchase a system to interface with the Echo facility it may be worth investing in that system.

The primary objective of this MSS is to decrease response time to EWSSL sponsors and to formalize ongoing procedures. Much of the MSS will be the formal implementation of control process. Koontz and O'Connel [Ref. 14: pp. 583-585] contend that a control process involves three steps 1) establish standards 2) measure performance against standards and 3) correct deviations from standards. One objective of this MSS is to provide a mechanism for the recording of tasks to be accomplished and a way of identifying between those tasks that have been completed satisfactorily and on time and those that have not.

Another objective is to minimize the impact that individual personnel has on operations. By developing formal data bases information becomes corporate knowledge.

For a MSS to be utilized it is mandatory that all data be current. This requires a dedicated effort to input data on a daily basis. This responsibility should be formally assigned. The design of the various input formats should be designed "user friendly" such that a data entry person can be utilized for this function. All three systems must be capable of accessing all data bases to minimize data entry errors and to assure that each system is using the same data. This does not imply that all systems must be able to change all data bases. Security provisions should be implemented to allow only certain agreed upon personnel be able to modify certain files.

C. SPECIFIC REQUIREMENTS

This section will discuss the requirements of each of the three MSS systems. Their required outputs, inputs, and processes will be detailed.

To satisfy the requirements of different levels of management the data supplied by the three systems could be filtered to the degree necessary for the intended user. This means that sponsors in Washington who require an overview of laboratory operations would receive a summarized report. The planning system would be used for management control and would use summaries from the operational and development systems as inputs. The specific requirements for these three systems will now be discussed.

a. Planning System

Primary outputs of the planning system fall into two categories. The quarterly reports and the year end reports show laboratory status at various times during the year . The REWSON plan, Task plan, and detailed program plan show future activities planned for the EWSSL. Current status reports can effect future planning reports.

The three planning documents provide essentially the same information but to different people or in slightly different detail. The REWSON plan and the detailed program plan are for Washington sponsors whereas the Task plan is for internal PMTC utilization. The development of these plans could be simplified if there was a greater deal of commonalty between them or ideally one document could serve the function of all three.

The process of developing the planning documents is a very unstructured affair. Projects to be included in the plans for the EWSSL come from ideas generated from discussions with numerous people with different backgrounds.

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As shown in Chapter IV the projects are chosen based on several criteria. The key criteria include EW system capability and development schedules, threat changes, and funding availability. What is required is a formal prioritization scheme for including projects into the plan. One approach would be to "score" potential projects based on previously agreed upon criteria chosen by a committee consisting of EWSSL sponsors and managers. Table V lists nonfinancial criteria that should be considered.

Formal financial analysis routines should be included in the planning subsystem. These financial analysis should never be used as the only criteria but can shed some light on the degree of risk . The U.S. government has determined that 10 percent is to be used as the cost of capital. A cost benefit analysis should be done on all projects using this cost of capital to see the profitability of the project. Payback time should also be included in the routines.

The planning system needs to maintain a data base containing the development schedules of all Navy, Air Force, and Army tactical airborne EW systems. The file should include: major system milestones, planned test time, source of information, and length of test required. The information should be updated each month for systems planned to be tested during the current year and each quarter for systems planned to be tested in the out years.

An input required for the planning process is the capabilities of other laboratories performing similar functions. The knowledge of other facilities will assure that duplication of effort does not take place and allow for a cross fertilization of information. Several organizations currently try to maintain data bases with this information. The data base is distributed in report form and is updated once a year.

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TABLE V
Proposed Criteria For Project Selection

Is the project EW mission specific?

Will the project give the EWSSL skills
and experience useful in the future?

Does the capability tc develop/manage
the development exist inhouse?

Can the project be used by many
different users?

Is the development state-of-the-art
and/or risky?

Does the project improve the status
of the EWSSL as a test facility?

Will the project be easy to use and
calibrate?

Do EWSSL personnel want to develop
the project?

Will the project fit into dailly
EWSSL operations easily?

A threat capabilities data base must be main-
tained tc provide input on what threat characteristics are

required for simulation and to know what changes have taken place in the systems. The STILO'S office should coordinate this effort and provide updates yearly.

The planning system provides both management control functions and operational control functions. Interface between the planning, operations, and development systems is required. One exchange required is a summary of current projects. The summary should be provided by the operation and development systems to the planning system quarterly for inclusion into the quarterly report and if deviations occur future planning documents can be modified.

A major requirement of the planning system is a simplification of the financial status reports currently being provided. The current reports are cluttered with information not routinely used and the reports are usually three to ten working days late. The time this becomes a real factor is at the end of the fiscal year when everyone is trying to close out accounts. During this time period the reports are even later. By maintaining a data base consisting of Job Order number, original amount, current amount, and past history the planning process could be greatly simplified. A "spreadsheet" approach should be utilized where monthly, quarterly, and yearly summaries could be displayed. Usage rates could be calculated from the data and used to predict year end balances. Access would be limited to financial data bases.

A data base of current tasks being performed is required. Data to be included is: Task name, engineer responsible, scheduled completion date, percent complete, and funds utilized. This data base should be able to be accessed in many different ways. A minimum requirement would be reports listing tasks complete, tasks overdue, tasks by engineer, and tasks whose percentage completion is grossly different from its funds used percentage.

b. Operations System

The primary result, or output, desired of the operations system is an efficiently operating laboratory. Efficiency is sometimes hard to quantify but some factors can be monitored. Actual time a test takes vice planned can be monitored. Deviation from planned time can be evaluated to see if EWSSL operations could be changed to decrease the deviation. Simulator down time should also be monitored. Reasons for the down time should be detailed and recorded to see if trends develop which could be changed by purchase of proper replacement parts or additional spare parts.

EWSSL scheduling greatly effects the day to day operations of the EWSSL. Scheduling is quite complex because of the multiple options of computer controllers, simulators, and test equipment available. The scheduling output needs to show the tests planned throughout the fiscal year. There is a great deal of information required to generate the schedule. This information includes: the simulator required, the EW system being tested, the scenario and computer required, test equipment required, EW system personnel contact with name, location, and telephone number, EWSSL personnel contact, number and type of EWSSL personnel required for test, and the time the EW system is available for the test and the duration of the test.

The process of generating the output from the above inputs requires a great deal of cross checking and coordination. A data base for each simulator containing test equipment and number and qualification of personnel required for each type of test can be maintained. Once test timeframe is known a cross check to see if personnel is available is performed. This involves checking to see if personnel are qualified and available. Availability is determined by other tests being performed in the laboratory

or annual leave schedule. Test equipment must also be checked for availability. This is determined by other testing in the laboratory, maintenance records and calibration schedules.

This process is ideal for computer implementation because data bases can easily be built containing all the required information. Costs of each test can be estimated from the above information and labor rates and supplied to the user much quicker then is presently the case. This information could then be fed back to the planning system to see if year end funding is impacted. This process should also maintain a log of all EWSSL operations for test reports and historical purposes.

A data base containing all EWSSL equipment, calibration cycle time, time required for calibration, and last calibration date needs to be implemented. Calibration down time can then be calculated for each piece of equipment and the test time for calibration projected.

c. Development System

The development system of the MSS would be used to improve management of the simulator development projects. This includes hardware developed either in house or with an outside contractor.

The system would use some of the same process as in the planning system for project management and financial control. The main difference would be in the quantity of the data. Results of the prioritization determination done in the planning system would be used as guides to monitor simulator development. The planning systems process used for scheduling could also be used to generate the simulator development schedule.

Contractor development efforts involve tracking a great deal of documents. A tracking system is required to

record date received type of review required and when
response is due. Personnel assigned the action of response
could then be flagged when response time is getting near.
Listings generating overdue responses, completed responses,
and personnel responsible could then be generated.

A difficult part of simulator development is the
procurement of hardware. To efficiently integrate simulator
hardware into a functioning piece of equipment components
must be available at specified times. Delays can be very
costly. A data base containing equipment ordered, order
date, cost, Job Order utilized, purchase order number,
supplier, and estimated delivery date must be maintained.
The information in this data base could be cross checked
with overall simulator development schedule to see where
conflicts occur soon enough to make improvements.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

This report presents a review of the current literature on MSS development, some current management philosophy, and an organizational analysis of the EWSSL located at PMTC, Pt. Mugu, California. The chapter on MSS development focused on general criteria of an MSS. The section on current management philosophy related ideas presented in In Search Of Excellence by Peters and Waterman to the Navy environment. The organizational analysis was performed using the Network model developed by N. Tichy. Using the knowledge gained on MSS development and the organizational analysis appropriate objectives and requirements for a MSS were developed for the EWSSL.

B. CONCLUSION

The organizational analysis showed that the current information and control systems are manual and/or slow and are not integrated to provide uniform information. One objective of the MSS is to decrease the time required to respond to inquiries from Washington sponsors. It was determined that the best way to improve response time would be to utilize an integrated computer controlled MSS.

Some information required by the EWSSL is controlled at bureaucratic levels higher then the organizational analysis included making it impossible to improve the response time of some of the information. It became evident that EWSSL operations could be improved if an integrated MSS was utilized at higher levels in the PMTC organization.

The organizational analysis showed how important experienced personnel are for the EWSSL to operate smoothly. The area of EW is unique. Experienced personnel are hard to find. The atmosphere of the EWSSL needs to be such that qualified, experienced personnel will want to stay in the organization. The analysis showed that laboratory personnel are mostly concerned with day to day problems. Attempting to solve these day to day problems would have the biggest impact on operations.

C. RECCMMENDATIONS

1. MSS Development

It is the authors' recommendation that a new integrated MSS for the EWSSL be developed. What is envisioned is an MSS utilizing some of the existing information systems structures and design techniques but all operating on one computer system. This approach would minimize the design costs, keep some of the familiarity of the current systems, and provide for an integrated system.

2. Central Processor

The central processor chosen for the MSS should be capable of interfacing with the Washington sponsors computer systems currently under development.

3. User Oriented

The users of the EWSSL MSS have the most to gain from its development. However, the MSS can only be effective if all concerned feel motivated to use it and understand how to use it. It is therefore recommended that these individuals be participants in the design and implementation of the MSS. The design should use the principles detailed in chapters II and III of this thesis.

4. Iterative Development

The development of the MSS for the EWSSL should be carried out in an iterative fashion. Development should begin with a specific subsystem being implemented and tested by itself to test the design concepts and applicability to EWSSL operations. It is recommended that the scheduling function of the operations system be developed first. It seems that all the information required for a design is never available so by developing only a subsystem not as much risk is encountered as in a complete development. The iterative approach also allows for a gradual transition from existing systems so that change is not to great at any one time. This allows time to build organizational awareness and to formalize commitment to the operation.

5. Information Delays

The EWSSL is dependent on other PMTC groups for information it requires. These groups may be either higher up the bureaucratic organization or in a different chain of command. Specific examples are the dissemination of memorandums from the EW directorate on down or the location of purchase orders in the supply department. It is recommended that a means of ascertaining where the delays are caused in the organization be implemented. Routing slips recording time in and out of each stop is one approach. Analysis of the delays should be done and corrections implemented.

6. People Constraint

The EWSSL operations depend a great deal on experienced personnel. Either one of two approaches can be used to minimize this constraint. Either additional personnel can be hired and trained to minimize the impact of one individual leaving the organization, a very costly endeavor, or

the MSS can be developed to the point where the knowledge required to operate the EWSSL is included in it, also very costly. It is believed that a compromise somewhere between these two extremes needs to be reached.

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